Idaho National Engineering and Environmental Laboratory

Cesium and Strontium Extraction Process Experience

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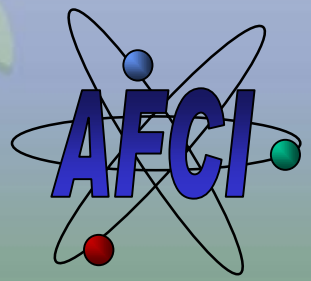
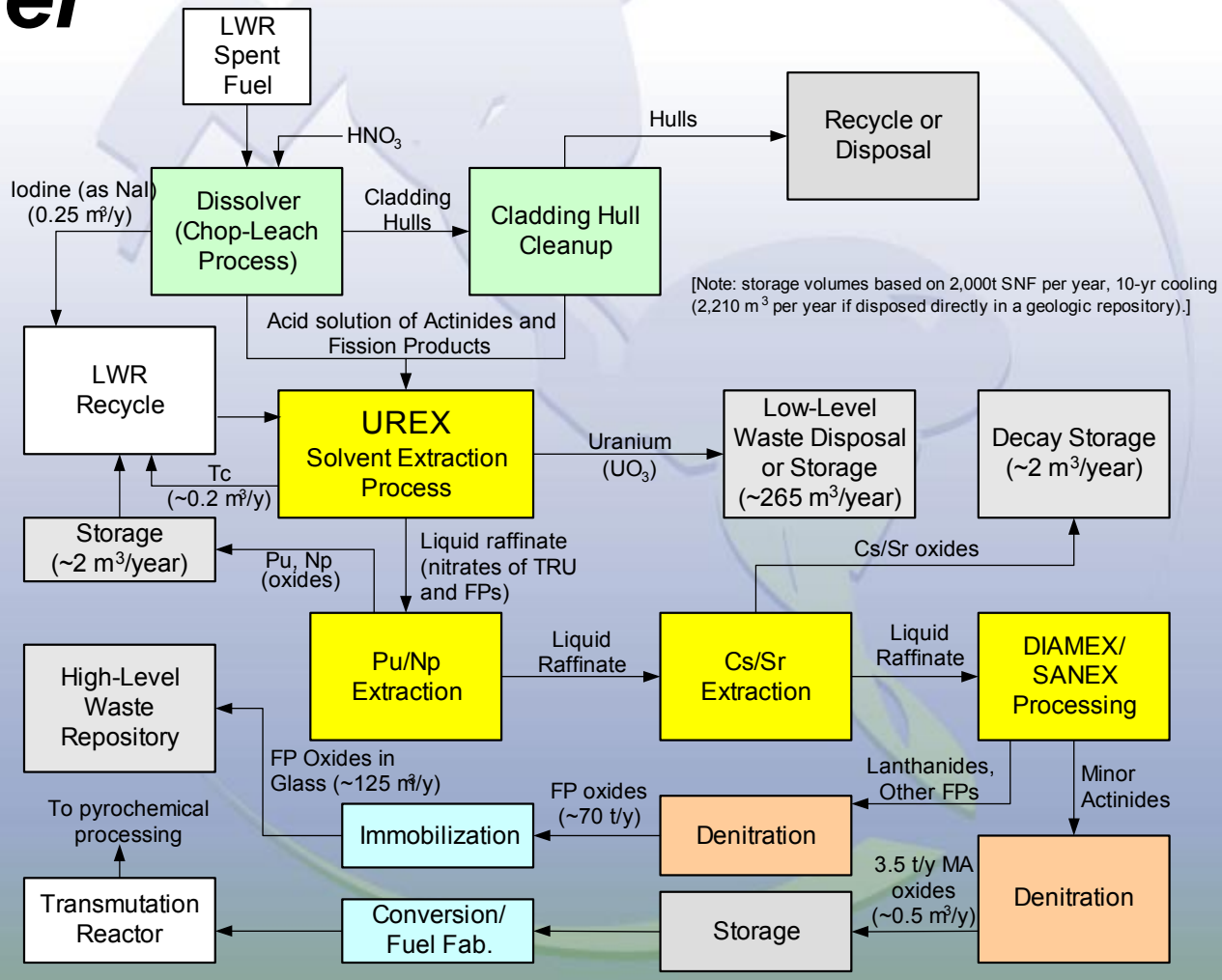


Background

- *Cesium-137 and strontium-90 are the primary heat generators in SNF*
- *Short half-lives facilitate storage/disposal alternatives until decayed (~300 years)*
- *Extensive research has been performed on Cs/Sr separation methods from wastes generated from SNF treatment for the last 30 years*

UREX+ Process for LWR Spent Fuel



Radionuclide Separations

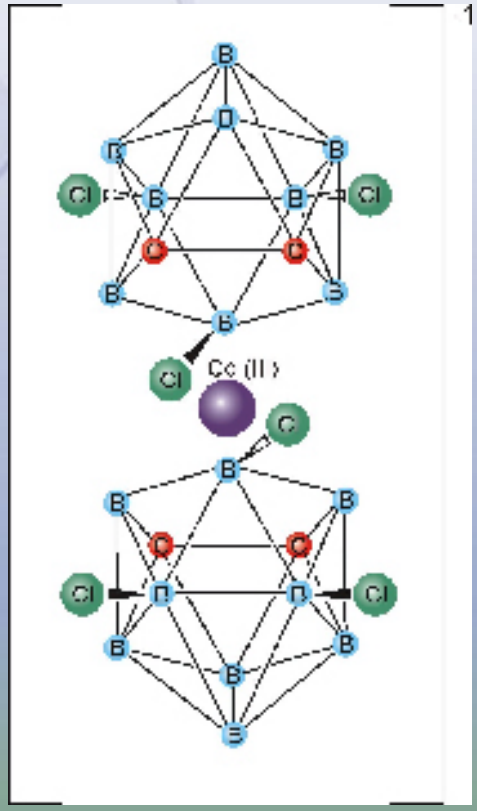
Actinides	Strontium	Cesium
PUREX	18C6 (SREX)	CDC*
UREX	CDC* (w/PEG)	Crown ethers
CMPO (TRUEX)		Calixarenes
DHDECMP		
TRPO		
Diamides		
		AMP
Precipitation		CST
		Hexacyanoferrate

***cobalt dicarbollide**

---------- Universal Extraction Process (UNEX)----------

Cesium Extraction

- ***Cobalt Dicarbollide (CDC)***
  - *Use of CDC to extract Cs reported by Rais, et al. in 1970's*
  - *CDC based extraction processes developed jointly by Czech and Russian scientists in 80's and 90's*
  - *Research in the US (LANL and INEEL) over last 10 years with Czech and Russian collaborations*
  - *INEEL actual waste flowsheet test resulted in 99.998% Cs removal*



Cesium Extraction (continued)

- ***Crown ethers/Calixarenes***
  - *Several processes developed around 18C6 and 21C7 –based extractants*
  - *Calixarene extractants developed in France and recently developed and applied by ORNL for SRS Alt. Salt Process*
  - *Real waste demos completed at SRS*

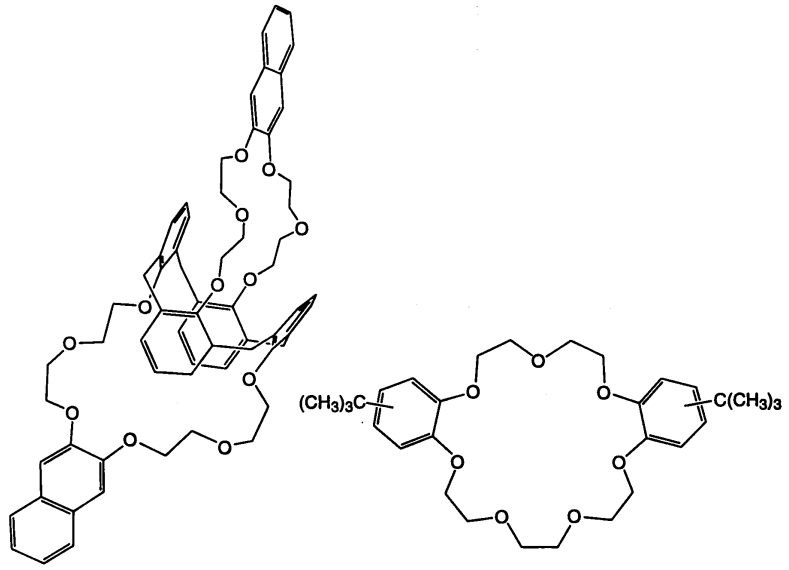
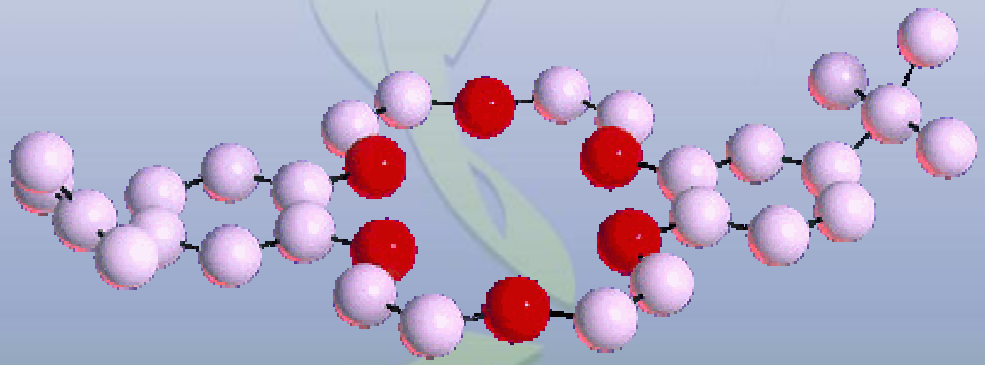


Figure 1. Calix[4]arene-bis-(2,3-naphtho-crown-6) (left) and bis-(*tert*-butylbenzo)-21-crown-7 (right).

Strontium Extraction

- *Strontium Extraction (SREX) process developed by Horwitz et al. from ANL in early 90's*
- *Extensive worldwide testing in mid-90's*
- *SREX process demonstrated in centrifugal contactors with actual INEEL tank wastes*



Combined Cs/Sr Extraction Processes

- ***Cobalt Dicarbollide with polyethylene glycol***
  - *Co-extraction of Sr with PEG first reported by Rais et al. in 70's, later developed by Czech and Russian scientists*
  - *Implemented on large-scale to separate mega-curie quantities of Cs & Sr from MAYAK p.a. (1996-pres.)*
  - *Process modified for potential implementation in U.S. and demonstrated on actual INEEL tank waste.*

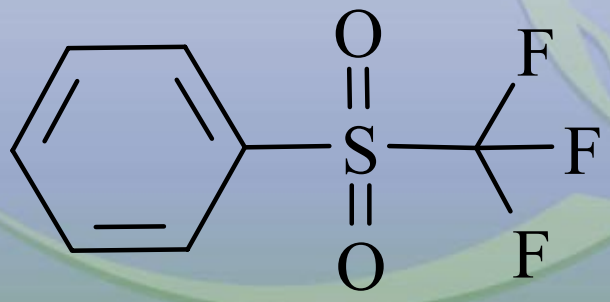
Combined Cs/Sr Extraction Processes

- ***Combined crown ether system***
  - *Developed in 90's by Horwitz et. al at ANL*
  - *Process utilized SREX extractant (DtBuCH18C6) + substituted dibenzo18C6 extractant*
  - *Tested in centrifugal contactors with simulated INEEL wastes at ANL*
    - *Very high separation/recovery of Cs and Sr*
    - *Poor stability of modified 18C6 in acidic media*

- *Potential for combined process based on DtBuCH18C6 and calixarene extractants*

Combined Cs/Sr Extraction Processes

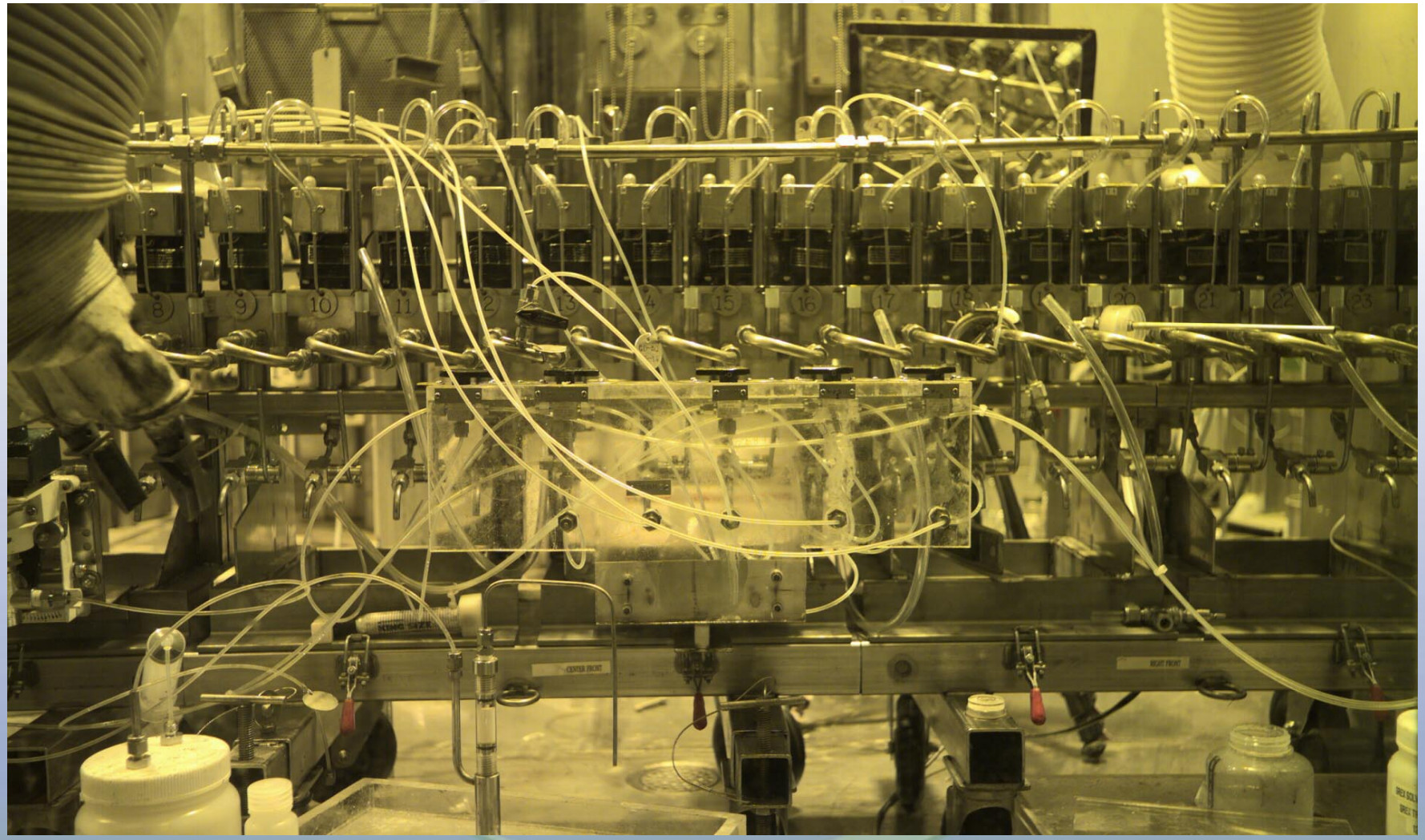
- ***Universal Extraction (UNEX) Process***
  - *CDC/PEG with actinide/RE extractant (CMPO)*
  - *Development of new diluent (phenyltrifluromethyl sulfone) to replace nitroaromatic compounds*
  - *Exceptional acidic and radiolytic stability*
  - *Demonstrated on actual INEEL tank waste, dissolved calcine and Russian (MCC) tank waste*



UNEX Test Results with Actual Radioactive Wastes in 2-cm Centrifugal Contactors

Removal Efficiencies

	INEEL Tank	INEEL Calcine	Russian Tank
Gross α	99.96%	99.92%	99.7%
Cesium-137	99.4%	99.99%	99.95%
Strontium-90	99.995%	99.73 %	99.99%



INEEL 2-cm centrifugal contactors in hot cell

Conclusions

- *Cesium and strontium can be effectively removed from acidic solutions resulting from SNF processing*
- *Testing to date has been with complex, high salt waste streams. Anticipated feed composition from proposed AFCI flowsheets would be less challenging*
- *Combined Cs/Sr extraction processes offer high throughput separations in a single process*
- *Many Cs/Sr processes have been demonstrated on actual radioactive solutions –ranging to full-scale implementation on > 1 million liters*